THE AUSTRALIAN NATIONAL UNIVERSITY

2004 Environmental risk assessment report for the Australian National University

by Dr Su Wild River,

ANUgreen
Strategies for Sustainability

Conducted using

CERAM
Comparative Environmental Risk Assessment Method

2004 Environmental risk assessment report for the Australian National University

Published at the Centre for Resource and Environmental Studies,
The Australian National University

Dr Su Wild River

Table of Contents

List of Tables

List of Figures

1 - Executive Summary

Since 1998, the Australian National University (ANU) has been undertaking environmental risk assessments. These have identified the ANU's priorities for pollution prevention and have helped to shape and direct a pollution prevention program. This is part of the Environment Program of Facilities and Services Division. The outcomes reported here include an 8% environmental risk reduction for the ANU overall since 1998. Current overall residual environmental risk is at 30% or lower. The ANU is making steady progress towards a best practice target of 20% residual environmental risk by 2007.

The report tracks the ANU's environmental risk reductions since 1998, highlighting the key areas of water pollution and waste. Graphs in Section 5 show the improvements in environmental risk management at the ANU. Section 6 presents photographs of the environmental hazards at the ANU and the improvements that have been made to pollution prevention over time. Section 7 identifies current priorities for risk reductions. Section 8 showcases best practice environmental management at the ANU.

2 - Background

Until recently, environmental risk management at the ANU has been informally shared between many operators. Three groups in particular tackle environmental risks as part of their core business. They are:

- Head Technical Officers within science laboratories – reducing quantities and toxicity of laboratory chemicals and providing pollution prevention systems directly to chemical users;
- ANU's Workplace Health and Safety Unit – coordinating policies, procedures and training in the management of hazardous materials; and
- Facilities and Services Division – providing infrastructure, training and ongoing management of water supply systems, drains, electricity, exhaust systems, recycling facilities and other systems.

Significant improvements in environmental risk have been achieved by each of these groups over recent decades. But gaps in environmental risk management existed because no single group was managing the entry of contaminants into the environment overall.

Since 2001, Facilities and Services Division has dedicated resources towards environmental risk management. An Environmental Risk Management Officer, Waste and Recycling Officer, and others have been working as part of the ANU's Green Team towards environmental risk reductions. This initiative has helped to identify and address the gaps in environmental risk management that existed under previous arrangements. The pollution prevention outcomes from these efforts are reported here.

The environmental risk assessments and management efforts link closely to ANU's compliance with the Australian Capital Territory's *Environmental Protection Act* (EPA). The EPA makes it illegal to cause contaminants (pollution) to enter the environment, causing environmental harm. It is also illegal to place contaminants where they could reasonably be expected to reach the environment, causing harm. Five main environmental impact areas are identified in Australian EPAs, and are considered in these environmental risk assessments. They environmental impact areas are:

- Water,
- Air,
- Waste,
- Noise, and
- Soil.

To date, the Green Team has led environmental risk reductions in the two key areas of water, through stormwater pollution prevention, and waste, through recycling initiatives. Improvements in tracking and managing air pollution – including greenhouse gas emissions – have also been ongoing. These work efforts are coordinated through the ANU's environmental management plan.

Stormwater systems drain directly to waterways, and in the ANU's case to Sullivan's Creek, in the Molonglo Catchment of the Murray Darling Basin. Previously, there was a high risk of stormwater pollution in most science and food building delivery bays, and many work areas at arts centres. All delivery bays at the ANU drain to stormwater, and work would be carried out above stormwater drains, with water being used to flush sites clean. There were also areas on campus where chemicals and wastes had been stored long-term above stormwater drains, and old chemical drums were decaying, allowing unknown contents to drain to stormwater.

The nature, scale, and management of the risks vary according to the following five building types. These are listed in order of their total contribution to inherent environmental risk at the ANU.

- Science,
- Arts,
- Service,
- Food, and
- Other buildings.

3 - Environmental risk scores, standards and targets

The ANU's environmental risk assessments are conducted using the Comparative Environmental Risk Assessment Method (CERAM)[1]. This was developed by the author, in partnership with operational and academic areas of the ANU and other agencies[2].

CERAM works by considering the likelihood and consequences of pollution, given the environmental conditions and the controls that are in place at each environmental hazard. It distinguishes the inherent and residual risk of pollution incidents, and reports these using a semi-quantitative, logarithmic scale. Inherent risk is a measure of the likelihood and consequences of environmental harm occurring from a hazard if there were no controls in place. Residual risk measures the likelihood and consequences of environmental harm taking account of controls. Percent residual risk identifies the portion of a risk that remains unmanaged despite the controls that are in place.

Table 1 below gives definitions for likelihood and consequences of environmental harm that are used in CERAM assessments. Table 2 is the risk management matrix complete

---

[1] Trademark CERAM.

[2] The ANU now offers a two-day graduate course award in CERAM's use and application in environmental risk assessment and management. Several research organizations and governments are now using CERAM and related techniques to prevent pollution. Other agencies that have been involved in CERAM's development and application in partnership with the ANU include Brisbane City Council, Queensland and Tasmanian Environmental Protection Agencies, the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and others.

with qualitative and quantitative risk scores.

Table 3.1 Likelihood and Consequences of Environmental Impacts

Likelihood (How likely is the event to occur)			Consequence (Significance of associated environmental impact)		
Rating		**Definition**	**Rating**		**Definition**
A	Chronic	The event is expected to occur in most circumstances	**5**	Catastrophic	Disaster with potential to lead to collapse
B	Frequent	The event probably will occur in most circumstances (e.g. weekly to monthly).	**4**	Major	Critical event, which with proper management , will be endured
C	Likely	The event should occur at some time ie. once in a while.	**3**	Moderate	Significant event, can be managed under normal procedures
D	Unlikely	The event could occur at some time	**2**	Minor	Consequences can be readily absorbed but management effort is still required to minimise impacts
E	Rarely	The event may occur only in exceptional circumstances.	**1**	Insignificant	Not worth taking action over

Source: Standards Australia 1999. As adapted by Wild River.

Table 3.2 Environmental risk matrix

Likelihood	**Consequences**				
	1 Insignificant	**2 Minor**	**3 Moderate**	**4 Major**	**5 Catastrophic**
A Chronic	8 (M)	16 (M)	32 (H)	64 (VH)	128 (E)
B Frequent	4 (L)	8 (M)	16 (M)	32 (H)	64 (VH)
C Likely	2 (N)	4 (L)	8 (M)	16 (M)	32 (H)
D Unlikely	1 (N)	2 (L)	4 (L)	8 (M)	16 (M)
E Rare	0 (N)	1 (N)	2 (N)	4 (L)	8 (M)

Risk Assessment Rating -
(N) - negligible (L) -low (M) - moderate (H) - high (VH) - very high (E) - extreme
Source: Standards Australia 1999. As adapted by Wild River.

There are three main outputs from a CERAM assessment that enable rigorous, consistent and defensible priority-setting for pollution prevention actions. The first is the total value of the inherent risks. This gives a measure of overall pollution potential in a realistic worst-case scenario. Activities, hazards or impact areas with the highest total inherent risk need ongoing management attention regardless of how good the controls are, since major problems might result if systems to prevent pollution from these ever failed. Individual hazards with inherent risks of 32 or more are generally considered to be high-risk (Brisbane City Council 2003).

The total residual risk is also important, as this is a measure of the actual risk of pollution, taking account of the controls that are in place. Activities or hazards with the highest residual risk are most likely to actually cause a pollution event. When the residual risk for a single activity is 16 or more, then improvements are called for. The appropriateness of this threshold is clear from Table 2 above. A residual risk of 16 means either that minor pollution is occurring chronically, moderate pollution frequently, major pollution is likely, and that a catastrophic event could occur at some time. An activity receiving this rating is not complying with environmental protection laws, and any responsible operator would seek to improve its performance.

The percent residual risk is a measure of the proportion of environmental risk that remains unmanaged given current controls. Cost effective risk reductions can usually be

achieved when 50 per cent or more risks are unmanaged. The 20 per cent residual risk target adopted by ANU in its current Environmental Management Plan is a best-practice target, with only 15 per cent of sites operating at a lower residual risk in the largest representative study to date (data from Wild River 1998). Percent residual risk is calculated as:

$$\text{Per cent residual risk} = \frac{\text{Residual environmental risk}}{\text{Inherent environmental risk}} \times 100$$

4 - Continuity between annual risk assessments

CERAM is as much a tool for learning and communicating about environmental risks, as for assessing and managing them. There is scope for amending previous assessments to incorporate new knowledge about environmental risks. Each year since 1998, new information about the ANU's environmental risks has been gained. Wherever relevant, this new knowledge has been extrapolated back to previous assessments so that both the current ratings, and the historical record of risks are increasingly accurate. The only disadvantage of this approach is imperfect continuity of assessments between years. For the most part, differences are very small, making little difference to the overall assessment. However some big changes have been made in the risk reporting this year, making this assessment apparently discontinuous with previous ones. This section describes the major differences between this and previous assessments, as well as the likely amendments and changes in future years.

The most significant shift in the ANU's CERAM assessments recent years was the inclusion of 'internal' environmental risks, which began with the 2003 report. For the first time, the previously unaccompanied site inspections were augmented by an assessment inside each building with a chemical storage shed. These assessments were accompanied by relevant Head Technical Officers. The 2003 report separated the reporting of the internal and external risks so as to retain the long-term record of the external risk data, while also reporting the new, internal findings.

There were marked differences between the internal and external risk ratings. Inherent environmental risk in the internal assessments was nearly double that for the external assessments, meaning that most of the ANU's environmental risks are present and managed within buildings, with contaminant sources and pathways to the environment never apparent from outside. At 30%, the residual risk within buildings was lower than the 38% recorded in the 2003 external assessments. This means that the ANU's environmental risks are greater within buildings, and they are better managed there too.

This year, the internal and external findings are combined. This is the best way to build on past knowledge while providing a simple and accurate assessment of current environmental risk priorities. In this assessment, the internal risk data was generally extrapolated back from 2003, without any change. Changes in environmental risk ratings over time were incorporated where they were known. The intention now is to gradually increase the accuracy of this historical record during future risk assessments, by checking the starting date that current controls.

One of the most significant reporting outcomes stemming from this change is in the

reporting of environmental risk reductions. The achievements reported in previous assessments included an 18% reduction in stormwater risk between 2001 and 2003 (reported in 2003). This report identifies only an 8% reduction in the risk of water pollution. This difference is due to the integration of higher inherent and lower residual risk ratings for the internal water risks with the stormwater risk ratings. The results are similarly changed for waste.

There are three main areas where the 2005 environmental risk assessment is likely to vary from this one. These are areas where knowledge gaps exist in this report, and where these gaps may be filled by investigations next year. The areas for further investigation include the following.

- Water wastage in science buildings due to the use of water aspirators rather than water-efficient vacuum pumps. Information on the extent of water savings devices within the laboratories was not available for this assessment.
- New waste and recycling systems commencing in 2004. Information on some such systems was not available for this assessment.
- Greenhouse gas emission data for the air pollution rating. This has only been assessed for some buildings – including Phenomics – which probably has unusually high greenhouse gas emissions.

It is most likely that the residual environmental risk for ANU will be lower than reported here, when this extra information is included.

5 – Trends in environmental risk management

Figures 5.1 and 5.2 show the magnitude of, and changes in inherent, residual, and per cent residual (unmanaged) risk since 1998 at the ANU. The risk scores in these graphs are the sum of all risk scores across the ANU.

The graphs show that the inherent risk environmental harm will occur from ANU operations is gradually increasing. This is partly the result of new buildings at the ANU, each adding potential sources of contaminants to the environment. Despite this, the residual or actual risk of environmental harm is decreasing. The improvements come from better environmental infrastructure and management practices across the ACTON campus and good environmental risk management in the aftermath of the Mount Stromlo fire. Reductions in unmanaged risk are shown clearly in Figure 5.2. Residual risk has decreased from 38% to 30% over the period it has been assessed[3]. Residual risk approaching the ANU's target of 20% by 2007.

[3] As noted above, the figures used here represent best estimates given available data. Per cent residual risk across campus is likely to be slightly lower (better) than reported here, due to conservative estimates in some common hazards.

Figure 5.1 – Total environmental risk at the Australian National University

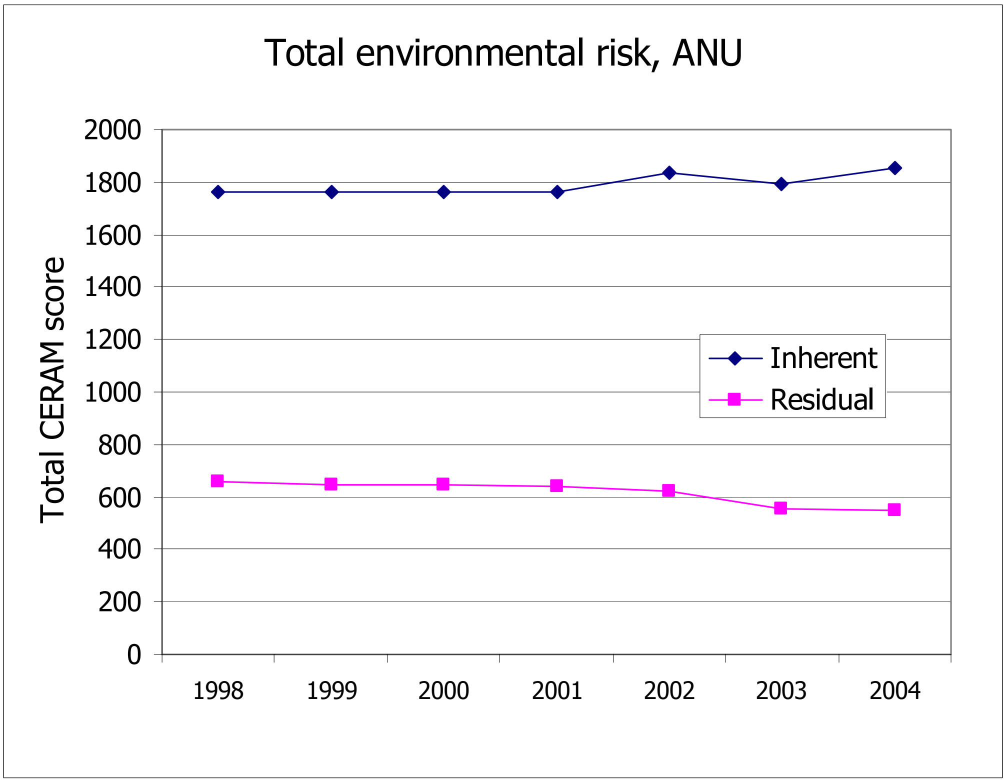
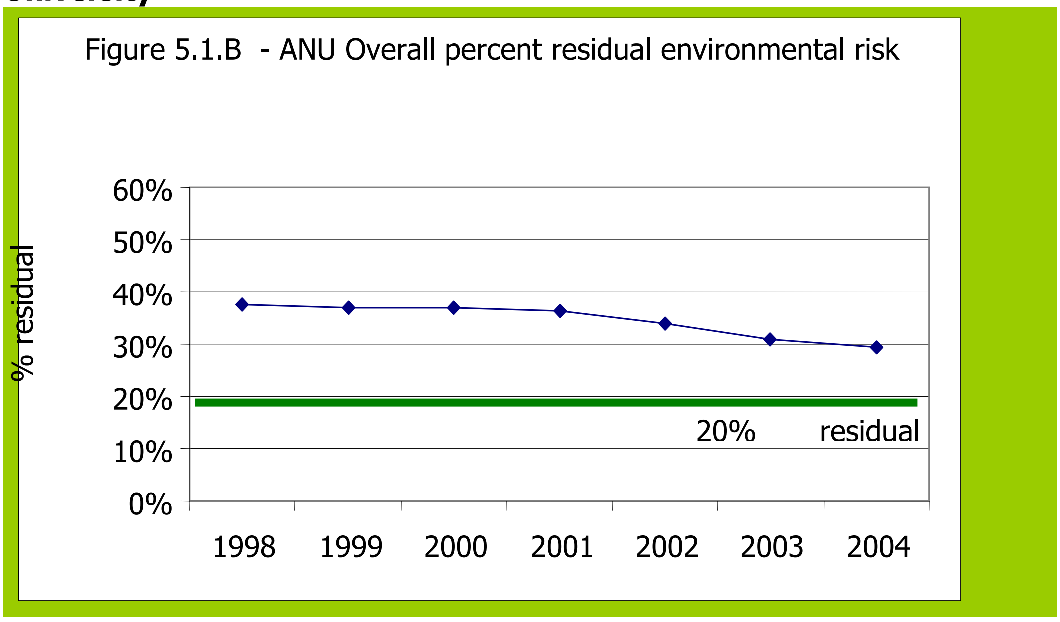
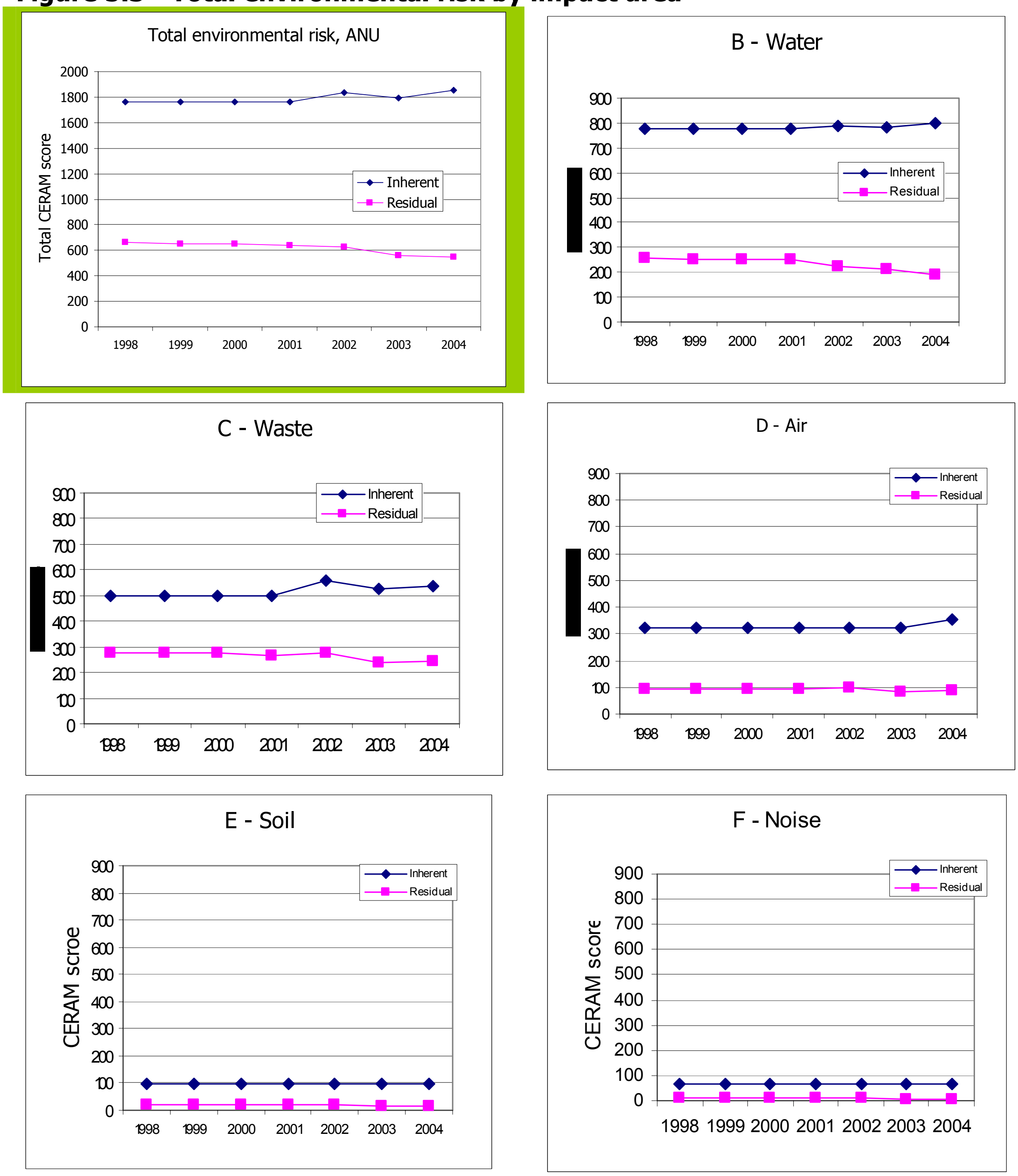


Figure 5.2 – Per cent residual environmental risk at the Australian National University



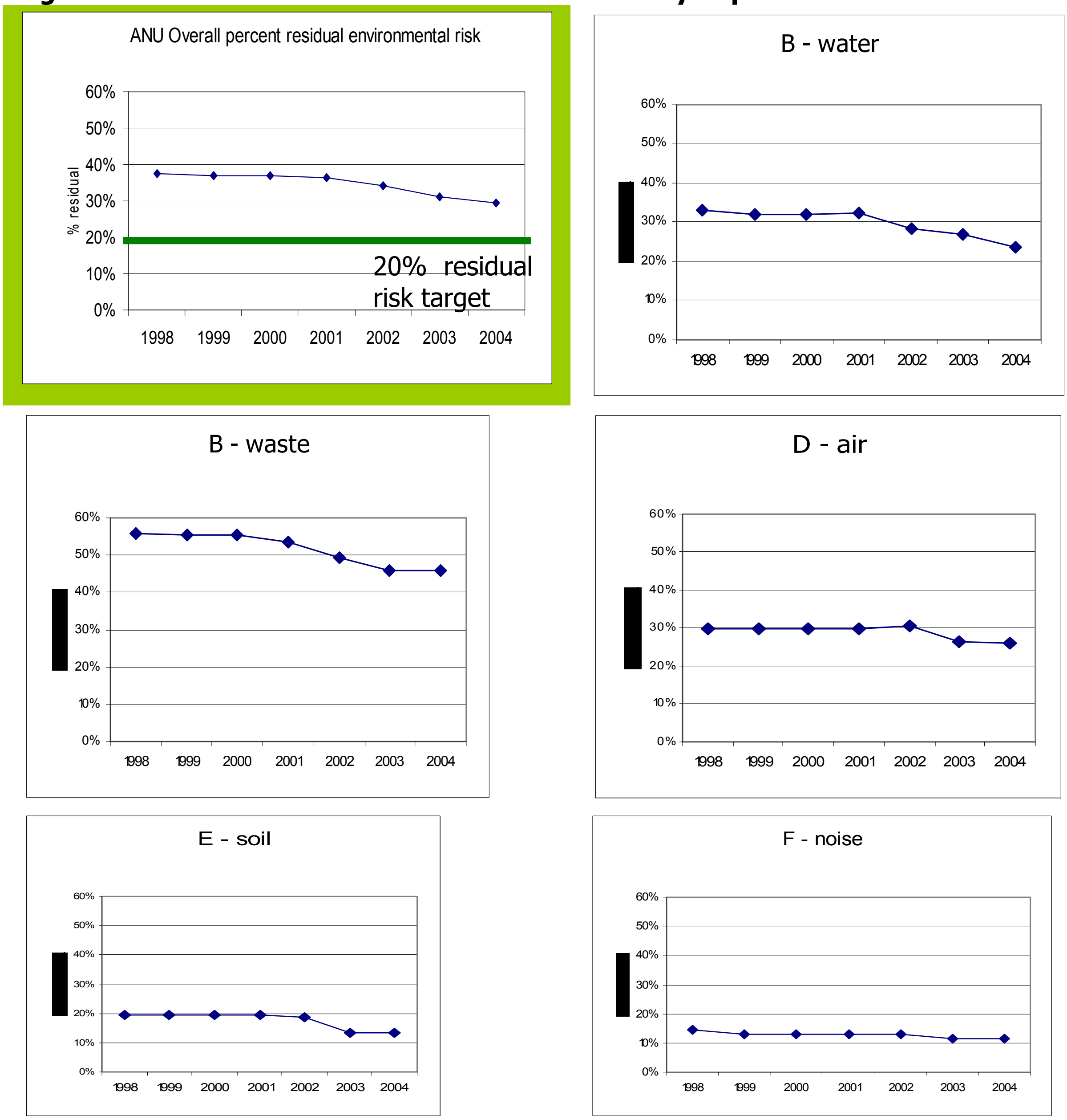
Trends in environmental risk are shown here by impact area. Water, waste and to a lesser extent, air, contribute most of the inherent risks on campus. The long-term trend in each of these impact areas is of rising inherent risk, and falling residual risk. The rise and fall of inherent risk between 2002 and 2003 was mostly due to the short-term impacts of the Mount Stromlo fire. This presented new, short-term risks of waste, including the need to dispose of considerable building and woody waste. Water pollution risk also increased with the instability of the soils following vegetation removal by fire. Both sources of risks had largely been resolved by late 2003, and had reduced again in 2004 (see figures 5.3 B and C).

Figure 5.3 - Total environmental risk by impact area



These graphs show that the proportion of unmanaged risks (per cent residual risk) is falling in every impact area. The risk of soil pollution (site contamination), and noise pollution, are already below the 20% residual risk target (Figures 5.4E and F). The risk of water pollution has dropped 9% from 32% to 24% since assessments began. Much of this risk reduction has occurred since the stormwater management program commenced in 2001 (Figure 5.4A). The per cent residual risk of waste is at a higher level than for other impact areas, and is reported here as 46% (Figure 5.4C), down 10% from 56% in 1998. Important improvements in waste infrastructure and collection systems are responsible for the improvement, but more work is needed in this area to achieve the 20% target by 2007[4].

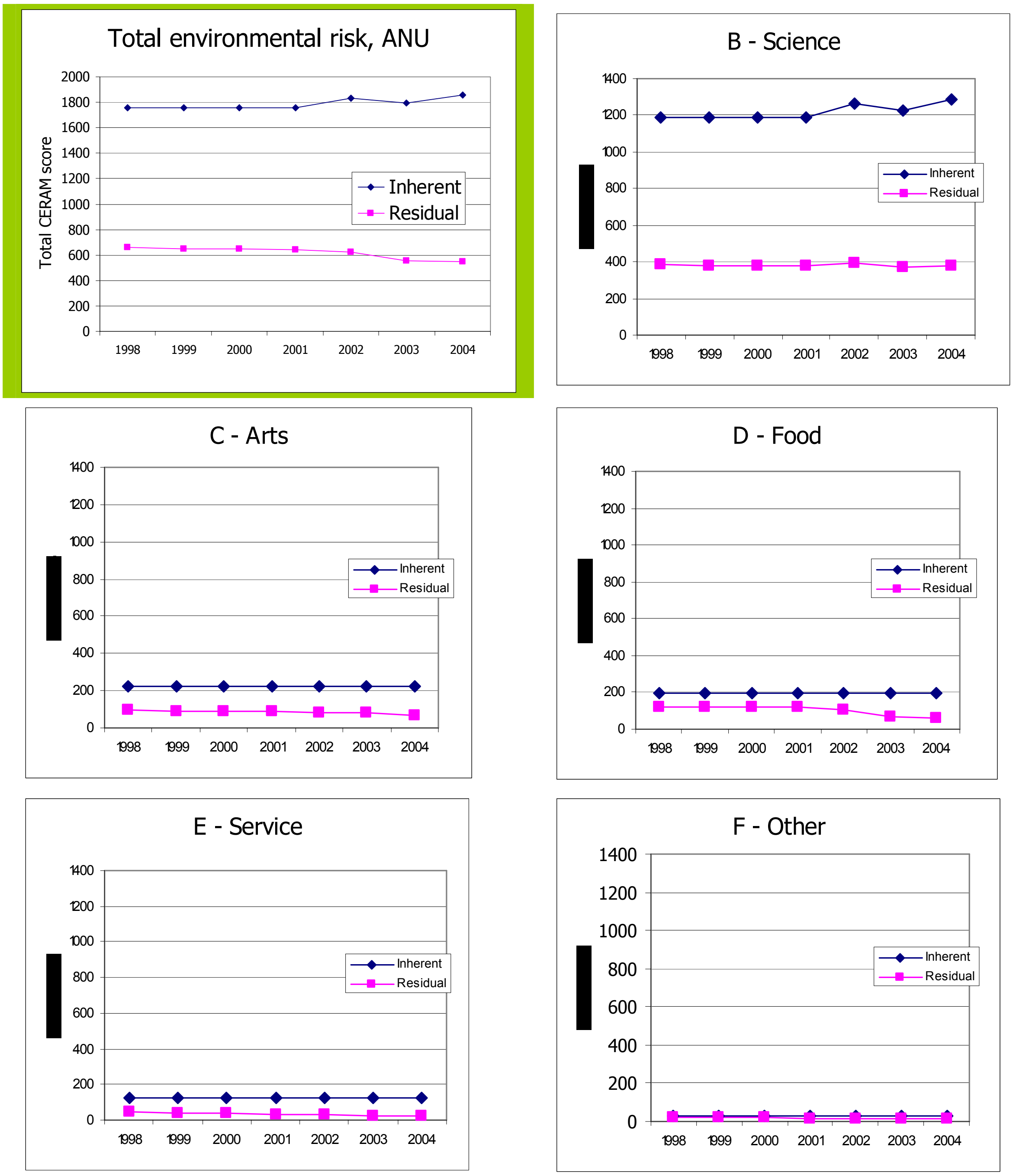
Figure 5.4 - Per cent residual environmental risk by impact area



[4] These ratings are probably over-rated in relation to water wastage in scientific laboratories. Future assessments will address this data gap.

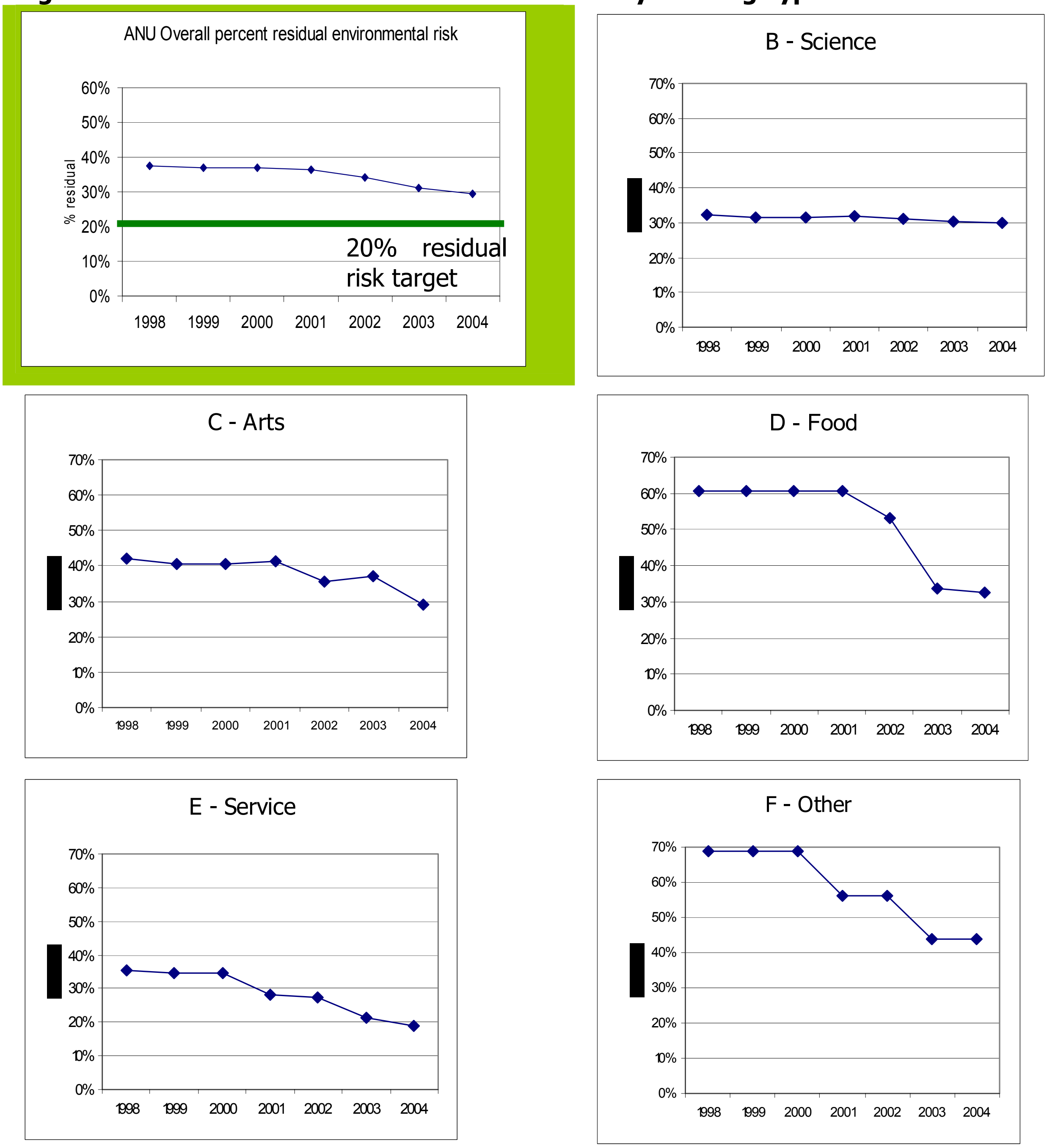
These graphs show science buildings have by far the greatest contribution to inherent risk at the ANU. They are also responsible for recent increases in inherent environmental risks. Residual risk at science buildings has reduced slightly in absolute terms, despite the rising inherent risks.

Figure 5.5 - Total environmental risk by building-type



These graphs show clearly that environmental risk reductions have been achieved in every building type, and that all are trending towards the 20% residual risk target. Science buildings have made the least dramatic changes in recent years. Only the service buildings are below the 20% residual risk target.

Figure 5.6 - Percent residual environmental risk by building-type



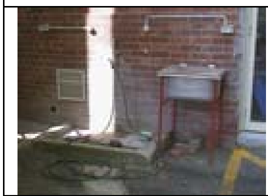
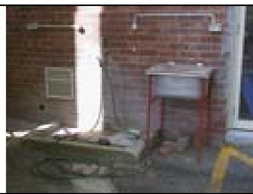
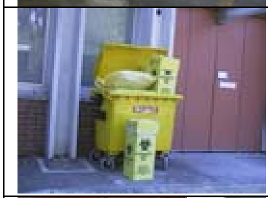
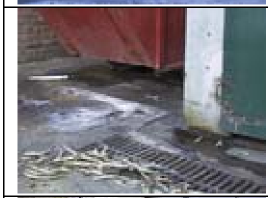
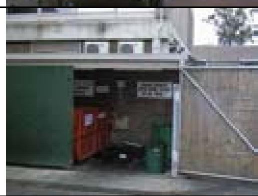
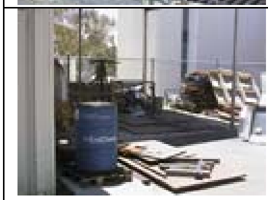
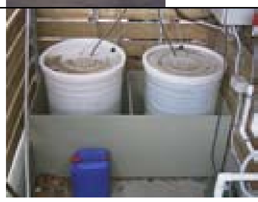
6 - Images of environmental risks

This section and those that follow use photographs taken over several years to showcase the environmental hazards present at the ANU, and the changes that have reduced environmental risk. Building types, and relevant dates are indicated.

6.1 Water

This section shows some of the many changes to water pollution prevention in recent years. Changes due to improved infrastructure are reported separately from those due to changed management practices. This distinction is useful since infrastructure changes are generally more costly, but more permanent than those affected by management shifts only.

Figure 6.1 – Changes to stormwater pollution risk due to new infrastructure

Before	Description	Current	Controls
	Arts. – before-2001 Wash station previously retrofitted by site users to drain into stormwater.		Looks and works the same way, but now drains to sewer.
	Science – 2000. Hazardous waste overflowing bin in stormwater risk area.		New management systems prevent excess hazardous waste.
	Food – before 2003. Compactor drains food waste to stormwater.		2003. Compactor moved to sewered, covered, secure area.
	Science – before 2002. Service area draining to stormwater shows signs of ongoing contamination.		2002-03. Installed oil/water sediment trap, stencil and bunding.
	Until 2003 – Science. Acids and bases kept beside one another, partially bunded in stormwater risk area.		2003. Full bunding installed.

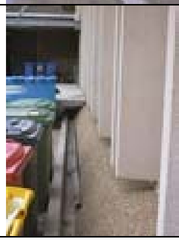
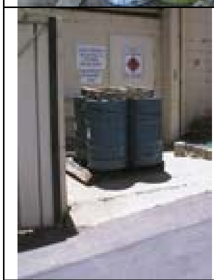
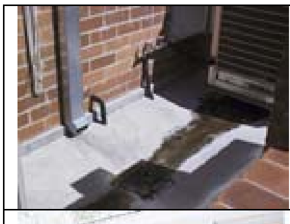
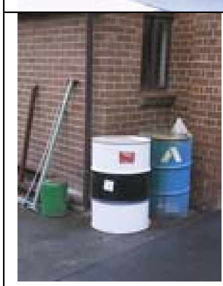
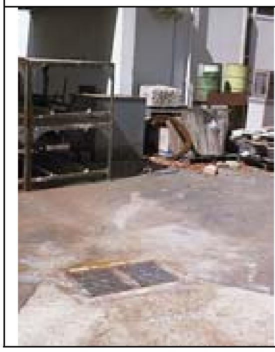
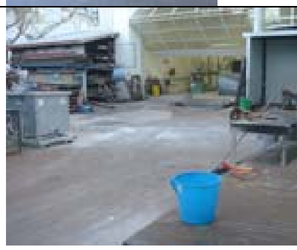
	Science – 1998. Delivery and waste pickup bay drains steeply to stormwater.		Science – after 1999. Extended delivery bay covers but doesn't protect stormwater. Residual risk is greater with the new bay.
	Science building – 1998. Exposed waste water pipe above stormwater.		Science – 1998. Pipe partially covered by extended loading bay.

Figure 6.2 – Reducing stormwater pollution through improved management

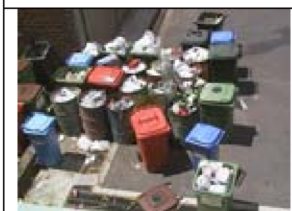
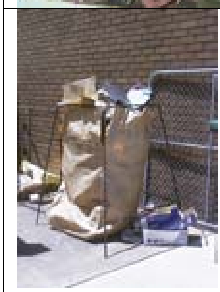
Before	Hazard	Current	Controls
	Science. 1998. Unlidded waste stored long-term in stormwater pollution risk areas.		Smaller quantities found less frequently. Spill-proof trays still needed when wastes are left out.
	Science – 1999. large drums of new chemical stored long-term in stormwater risk area.		From 2000. Bunded trolley for storing and moving contaminants.
	Waste toiletries products washed to stormwater. Food (residence) building. 1998		Drain stencils and the Cleaners training programs have reduced cleaning to stormwater.
	Food buildings keeping waste cooking oil in unlidded or unsealed containers above stormwater		2004. First modern, minimal pollution food-oil storage system on campus.

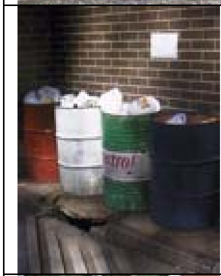
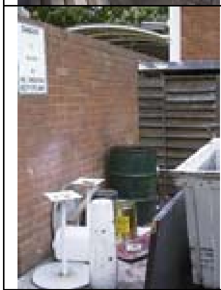
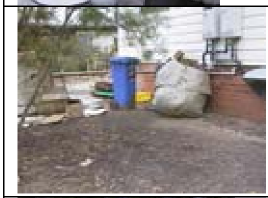
	Across campus – before 2001. Drain types not known in many outside work areas.		All drains in delivery bays and waste areas stenciled by end of 2002. Drain stenciling is ongoing.
	Food building – before 2001. No distinction between sewered and stormwater risk areas		Food building 2002 onwards. Clearer distinction in waste areas.
	Science – 2002. Unlidded chemical drums above stormwater in loading bays.		Stormwater risk area kept free of contaminants after drain stenciling and stormwater training.
	Arts - before 2002. Stormwater rain prone to blockages due to contaminants.		Sediment trap installed, and drain stenciled and re-stenciled. All appear to be working well.

6.2 Waste

This section shows changes to the risk of waste. The installation of recycling stations across the ACTON campus, together with better coordination in recycling contracts have helped to reduce this risk.

Figure 6.3 – Risk reductions in waste and recycling

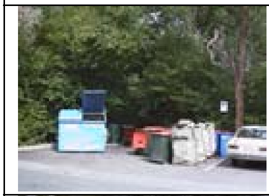
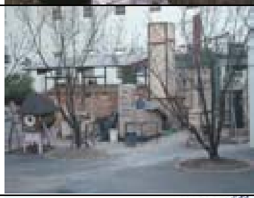
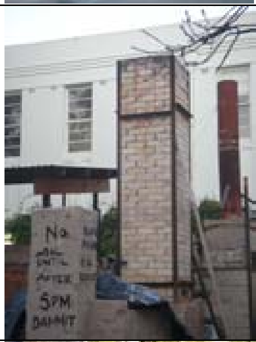
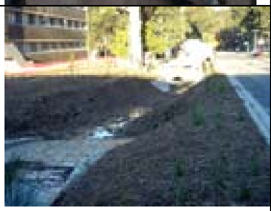
Before	Description	Current	Controls
	Waste – before 2002. disorganized, ineffective food-waste recycling systems and infrastructure		Improved systems and increased frequency of pickups have improved recycling outcomes.
	Offices – before 2002. Disorganized, ineffective food-waste recycling systems and infrastructure		Improved waste and recycling systems across campus.

	Science – Before 2002. Site contamination. Unlabelled, permeable lidded containers stored long-term in gravel carpark.	Drums removed.	
	Food – before 2004. Unique, but functional recycling system, with evidence of waste leaching to stormwater.		After 2004 – Standard recycling system. Area clean and functional.
	Food – before 2002. Cluttered, disorganized waste area, including open oil drum.		After 2002 – well organized and efficient waste area.
	Small food area until 2004. Low levels of recycling achieved.		Since 2004. Improved, standardized waste and recycling systems.
	Science. Some disorganized waste areas before 2002.		Improvements but many areas could still be better organized.

6.3 Other impact areas

Changes in the other environmental risks are shown in this section. Many of these risk issues interact with the water and waste risks shown above.

Figure 6.4 – Environmental risk changes in other impact areas

Before	Description	Current	Controls
	Food – waste area drains to soil. Minor evidence of contamination.		New waste area minimizes site contamination, but represents a risk of stormwater pollution.
	Arts – before 2003. Outdoor work area drained contaminants to stormwater.		2003. New sediment traps installed and working well.
	Before 2003 – Air. Arts. Kiln chimney releases black smoke during reduction firings. Stack height lower than surrounding sensitive areas.		2004. Black smoke avoided through timing of firings. The sign reads "No oil until after 5pm dammit".
	2003.-Water. Changed conditions in Sullivan's Creek tributary – creek bed scarred by truck tyres during car park construction.	 	Engineered creek bed. Changed ecological conditions for previous frog and other wildlife populations.

6.4 Buildings – Phenomics

The Phenomics building (a mouse-breeding facility) is showcased here because some of the environmental risks and management practices within it are new to the ANU, and because environmental risk issues are unusual in many ways.

From top left, pictures show the building from outside; delivery bay doors showing high security; large autoclave and visitors in protective clothing; animal (bedding and food) waste; and general waste. Environmental management issues at Phenomics are unusual in that the major effort is in preventing contamination and disease getting to the mice that are housed inside. Humans and food are among the potential contaminants, whereas outputs are relatively clean. Recycling of organic wastes is difficult due to the high quantities and specific makeup. Energy use is extremely high due to the dry (vacuum) waste removal system and other features, which otherwise set new standards for pollution prevention.

Figure 6.5 – Environmental risk issues in the new Phenomics building

7 - Current priorities

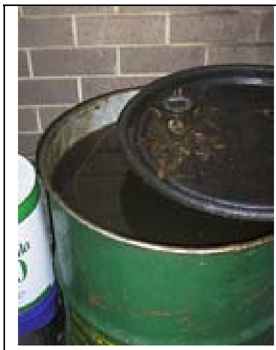
This section shows areas at the ANU where further work is needed to prevent pollution.

As with previous years, the assessment looked for minor environmental offences under the ACT Environmental Protection Regulations 1997, No. 36. Schedule 5 of the Regulation lists offences that can incur on-the-spot fines. There are two levels of offence here. The first is more serious, and relates to direct pollution of the stormwater system by paint, automotive fuels, oils or greases, cooking fats or oils, degreasers, detergents, or by animal, food or other wastes. One instance of this was observed during the 2004 inspection, with two in 2003 and five in 2002.

The second level of offence is less serious, and relates to leaving any of the same substances unattended within 10 metres of a drain, if they are exposed to rain or runoff. For the first time, no instances of this were observed. Several drains however, still show evidence that contamination of stormwater continues intermittently. They are indicated as having 'borderline compliance' in the photographs below.

Figure 7.1 – Ongoing challenges in stormwater pollution prevention

 Arts – machine leaching sediment to stormwater. Borderline compliance.	 Food - Stormwater drain used for waste at food building. Stencil has faded or been built over twice. Borderline compliance.
 Science - Some chemical stores are bunded but lack spill kits.	 Science - This chemical store has no spill kits, long distances to chemical use areas, no bunding, and spills would flow to area beyond fence, making it difficult to clean or contain a spill.

 Food - most areas still have old-style oil drums, with loose-fitting lids, near stormwater drains.	 Food – oily spills from waste oil drums can be observed in several locations. Borderline compliance.
 Science – Refurbishments of some buildings are expected to remove some longstanding environmental hazards, such as this animal waste silo that frequently leaks. Borderline compliance.	 Science – Refurbishments of some buildings are expected to remove some longstanding environmental hazards, such as this stormwater drain that runs during dry weather. Borderline compliance.
 Arts - Sink is disconnected from drainage but not water supply. A sign says not to use it, but there is evidence of ongoing use. Borderline compliance.	 Science - Most emergency showers drain to stowmater. While quantities of any contaminants shed during showering are likely to be minimal, their presence indicates liquid contaminants. These areas should all have suitable spill kits.
 Food - Stormwater pollution risk from compactor has decreased significantly, but spills still occur during waste pickups. Borderline compliance.	

Ongoing work to prevent pollution is also needed in several other impact areas, and parts of the campus. As was indicated in the graphs in Section 5, there are many waste issues

still to be addressed, and many science buildings still need to achieve significant risk reductions if the ANU is to meet its 20% residual risk target by 2007. Some of these issues are shown in the following photographs.

Figure 7.2 – Ongoing challenges in other impact areas

Other building type - corroded drum of un known liquid from loading bay.

Food - some areas are still not using standard, effective recycling systems.

Science - Small quantities of waste chemicals are sometimes still left unprotected for pickups.

Science - some unlabelled, degrading chemical containers remain.

All building-types - skips on construction sites still usually contain recyclable or reusable materials.

Science – some waste or storage areas remain in poor condition despite refurbishments.

Arts – there is still evidence that students lack knowledge about correct use of stormwater and sewage drains.

Science – some chemical and waste stores vulnerable to fire, vandalism.

 General – a couple of drains in high risk areas still need stenciling.	 General – erosion control on building sites is sometimes ineffective.

8 - Best practice

It is worth highlighting the hazards present at the ANU where there is best practice environmental management. Best practice is typically difficult to determine, but the CERAM methodology, and this long-term approach to environmental risk assessment allows such a determination. The environmental management systems protecting individual hazards at the ANU can be considered 'best practice' if they:

- Result in a residual risk of less than 20%;
- Have a lower per cent residual risk than other similar hazards at the ANU;
- Have prevented pollution during potential pollution incidents; or
- Have a lower per cent residual risk than similar activities in comparable buildings in research institutions[5].

This section shows some of the examples of environmental management practices at the ANU, that satisfy all of the relevant criteria set out above. Figure 8.1 shows examples of best practice environmental management at the ACTON campus. Figure 8.2 shows the chemical store at Mount Stromlo before the 2002 fire presented a serious potential pollution incident. The photographs in Figure 8.3 show that the chemical storage shed and its flammable contents were unaffected by the fire that destroyed all surrounding buildings. The construction and layout of this chemical storage shed have certainly been shown to be effective, and it is fitting to recognize this facility as operating at best practice.

Figure 8.1 – Examples of best practice on the ACTON campus

 Science – water, soil. Wash bay and soil store is in covered, bunded area.	 Science – soil. Bunded fuel store needs ongoing maintenance since it is unroofed, but shows no sign of hydrocarbon build-up.

[5] The participation of other research institutions in CERAM training courses has provided the opportunity for ANU laboratories to be compared with those in other institutions.

Service – soil. No evidence of material leakage from gardeners' soil yard even during major rain events.

Food – waste. High recycling rate achieved through elephant's foot compactor.

Food – water, waste. Fully-sealed cooking oil disposal. Prevents spills to stormwater. Not yet common on campus.

Services – water, waste, soil. Fuel storage, wash bay, water recycling and stormwater management.

Figure 8.2 –Mount Stromlo chemical store before the fire

Chemical store before the fire, showing bund seal below door, sump, stacked volatile liquids.

Chemical store showing spill kit. Before fire.

Figure 8.3 – Mount Stromlo chemical store after the fire

Chemical store untouched by fire.

Spill kit untouched by fire.

Stored flammable liquids untouched by fire.

Surrounding buildings with fewer flammable items did not survive fire.

9 - Bibliography

ACTEW Corporation 2002. "Acceptance Criteria for Non-Domestic Waste (Trade-Waste) Discharging into the Sewage Network". Discussion Paper Version 1. 5th November 2002. ACTEW Corporation. Canberra.

Australian Capital Territory Government. 1997. *Environment Protection Regulations 1997 No. 36.* Schedule 5. Canberra. Australian Capital Territory Government.

Australian National Unviversity. 2003. Environmental Management Plan. Canberra. Australian National University. http://www.anu.edu.au/facilities/anugreen/admin/plan/index.html

Brisbane City Council. 2003. Environmental Due Diligence System: Implementation Manual. Brisbane. Brisbane City Council.

Grime, K. and Martin, E. (university solicitors) 2003. Land Issues – Applicability of ACT Legislation. Unpublished legal opinion, 24 July. Canberra. Australian National University.

Standards Australia 1999. *Australian / New Zealand Risk Management Standard*. AS/NZS 4360:1999.

Sullivan, R. 1998. Assessing the acceptability of environmental risk – a public policy perspective. *Australian Journal of Environmental Management*. 5(2): 72-80.

Sullivan, R. and Hunt, A.R. 1999. Risk assessment: the myth of scientific objectivity. *Environmental and Planning Law Journal*. 16(6): 522-530.

Wild River, S. 1997. Brisbane City Council environmental benchmarking study: a report into environmental and other outcomes from Brisbane City Council's 1995-97 implementation of the Environmental Protection Act 1994. Unpublished report for Brisbane City Council.

Wild River, S. 1998-2003. Annual Environmental Risk Reports. See for example http://www.anu.edu.au/facilities/anugreen/EMPC/Reports/02-EnvironmentalRisk.html. Canberra. Australian National University.

Wild River, S. 1998. Statewide benchmarking Study into Environmental and Other Impacts of the Queensland Environmental Protection Act 1994 for Environmentally Relevant Activities: Technical Report on Benchmarking Issues for Administering Authorities. Unpublished report for Queensland Department of Environment.

Wild River, S. 2001. Comparative environmental risk assessment: a practical and applied method. *Austrlaian Journal of Environmental Management.* December. 8: 211-218.